Appendix A:

Modeling Report

Camp Branch

WBID: 251

Nutrients and Dissolved Oxygen

February 2013

Region4 serving the southeast

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1. Watershed Description

Camp Branch (WBID 251) is one of the 172 waterbody segments in the Choctawhatchee River Basin and one of eight waterbody segments in the basin included on the 1998 303(d) list for Florida. The watershed is located in the southeastern portion of Holmes County, Florida.

The headwaters of Camp Branch (WBID 251) are in the southeastern portion of Holmes County. The creek flows in a southeasterly direction for approximately 5.4 miles to Open Creek, eventually draining into Holmes Creek, a principal tributary of the Choctawhatchee River. The creek receives flow from a number of smaller branches.

The drainage area within the Camp Branch WBID boundary is approximately 7.7 square miles (mi^2) (4,927 acres) and is predominantly made up of agricultural and forested land. Additional information about the hydrology and geology of this area is available in the Basin Status Report for the Choctawhatchee-St. Andrew Bay Basins (Florida Department of Environmental Protection [FDEP], 2003).

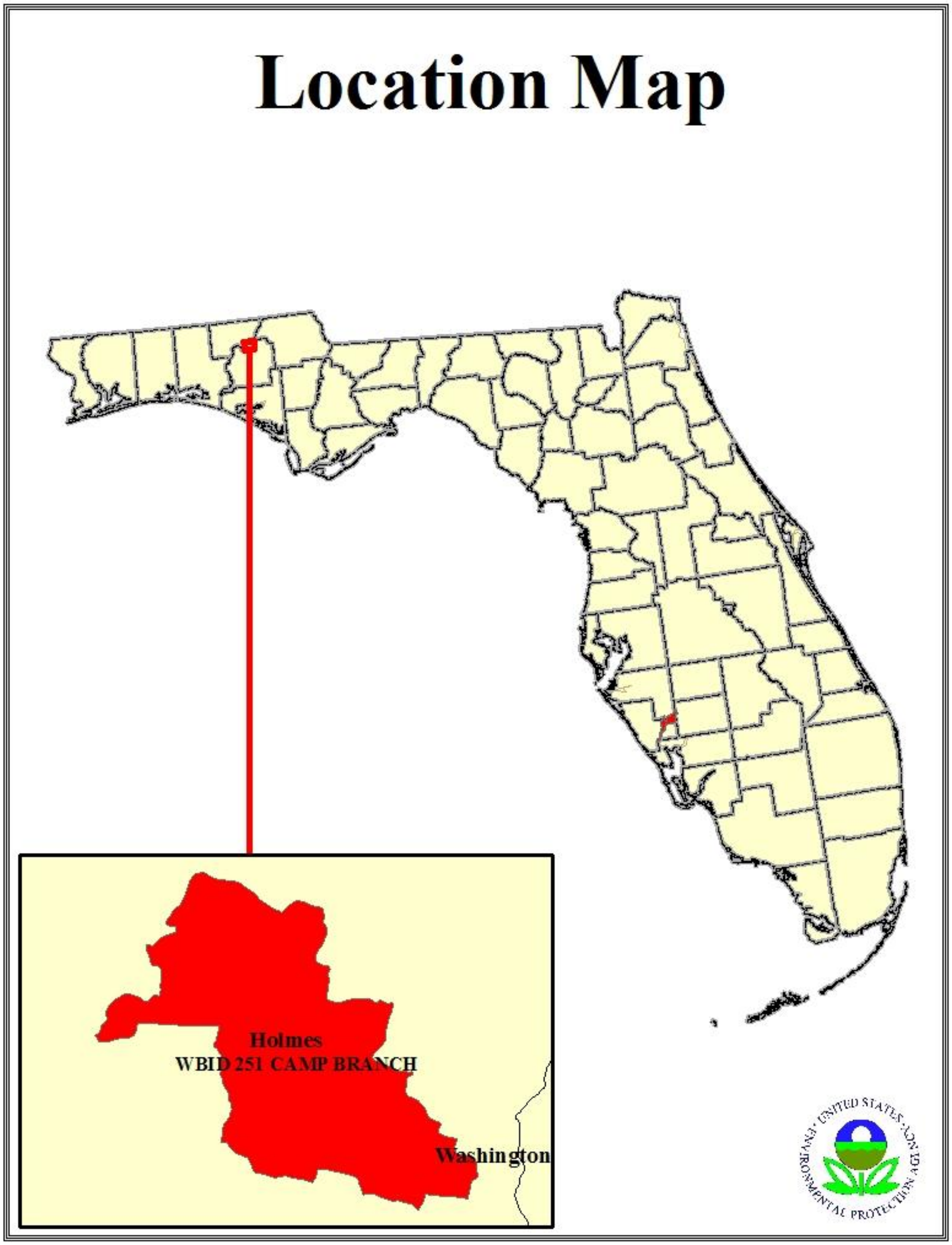


Figure 1 Location Map for Camp Branch

The landuse distribution for the Camp Branch watershed is presented in Figure 2.

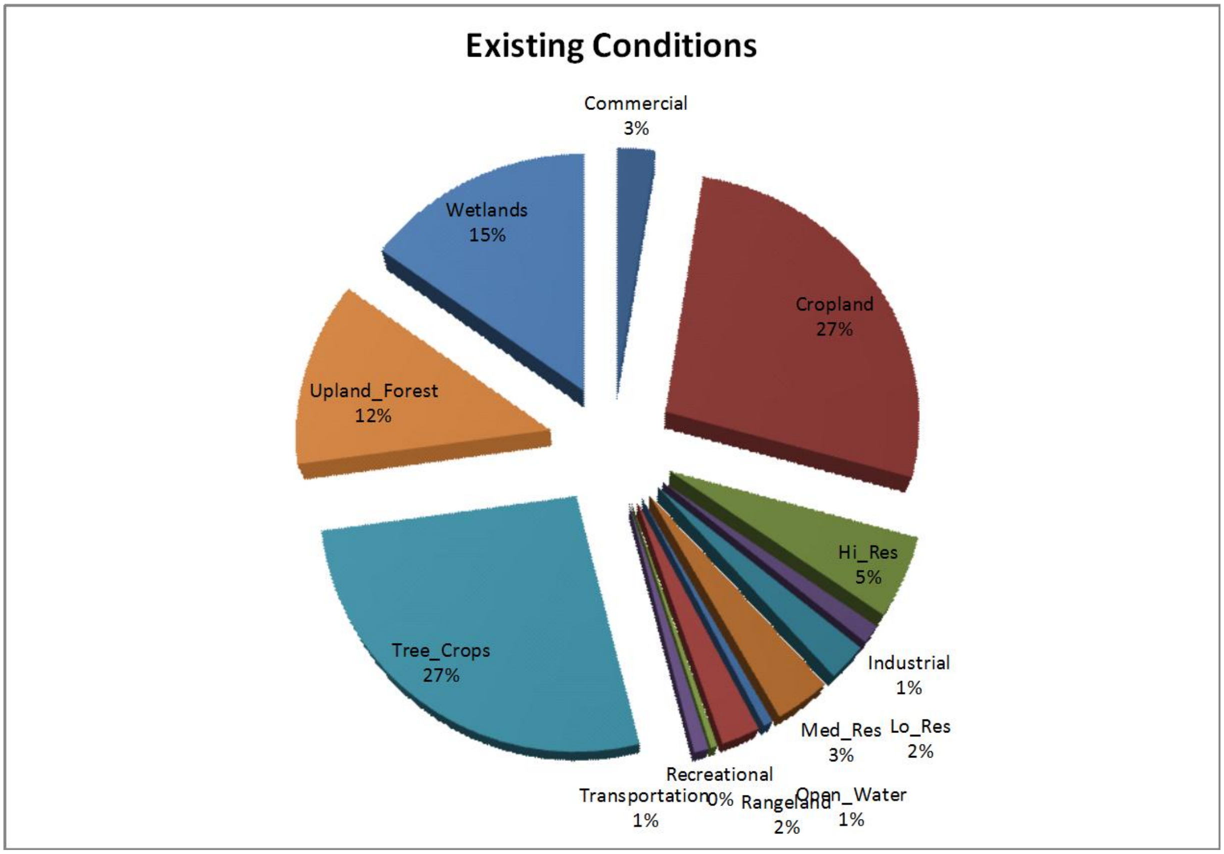


Figure 2 Landuse Distribution for Camp Branch Watershed

2. TMDL Targets

The TMDL reduction scenarios will be done to achieve a dissolved oxygen concentration of 5 mg/L in within Camp Branch or establish the natural condition.

3. Modeling Approach

A coupled watershed and water quality modeling framework was used to simulate biological oxygen demand (BOD), nutrients (total nitrogen and total phosphorus), and chlorophyll a (Chla) and dissolved oxygen for the time period of 2002 through 2009. The watershed model provides daily runoff, nutrient and BOD loadings from the Camp Branch Watersheds. The predicted results from the LSPC model are transferred forward to the receiving waterbody model Water Quality Analysis Simulation Program (WASP 7.4) (USEPA, 2009). The WASP model integrates the predicted flows and loads from the LSPC model to simulate water quality responses in: nitrogen, phosphorus, chlorophyll a and dissolved oxygen. Both LSPC and WASP will be calibrated to current conditions, a natural condition. The WASP model will be used to determine the percent reduction in loadings that would be needed to meet water quality standards.

3.1. Camp Branch Watershed Model

The goal of this watershed modeling effort is to estimate runoff (flow), nutrient (total nitrogen & total phosphorus) and BOD loads and concentrations from the upstream watersheds flowing into the Camp Branch. The Loading Simulation Program C++ (LSPC) as the watershed model.

LSPC is the Loading Simulation Program in C++, a watershed modeling system that includes streamlined Hydrologic Simulation Program Fortran (HSPF) algorithms for simulating hydrology, sediment, and general water quality on land as well as a simplified stream fate and transport model. LSPC is derived from the Mining Data Analysis System (MDAS), which was originally developed by EPA Region 3 (under contract with Tetra Tech) and has been widely used for TMDLs. In 2003, the U.S. Environmental Protection Agency (EPA) Region 4 contracted with Tetra Tech to refine, streamline, and produce user documentation for the model for public distribution. LSPC was developed to serve as the primary watershed model for the EPA TMDL Modeling Toolbox.

3.1.1. Camp Branch Watershed Delineation and Landuse

The surrounding watershed that drains directly to the Camp Branch is presented in Figure 3. This WBID (red outline) was delineated into 6 LSPC sub basins (yellow outline) to simulate the runoff and pollutant loads.

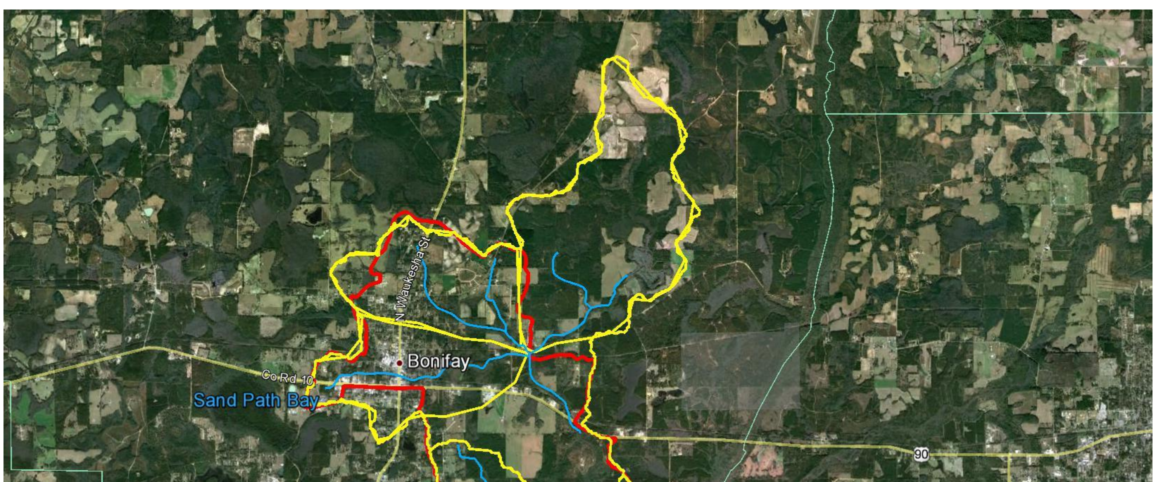


Figure 3 Camp Branch Watershed Delineation

Figure 4 illustrates the Florida Landuse Classification (Level-1) for the Camp Branch surrounding watershed.

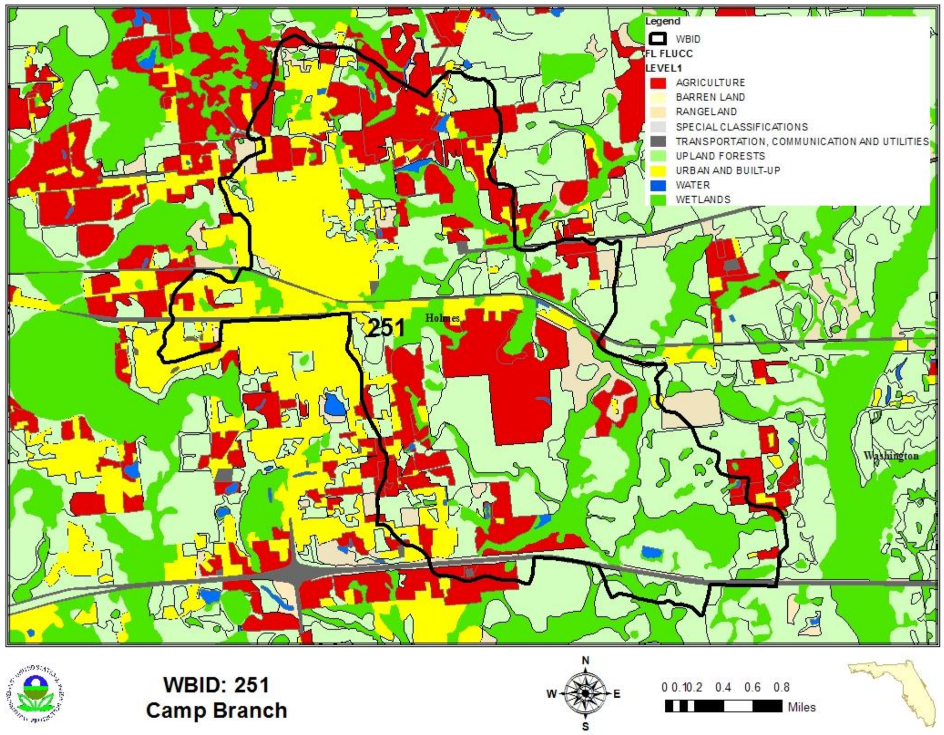


Figure 4 Camp Branch Watershed Landuse Distribution

3.2. Camp Branch Watershed Runoff

The LSPC watershed model was developed to simulate hydrologic runoff and pollutant loadings in response to recorded precipitation events for the current and natural conditions.

3.2.1. Meteorological

Rainfall and other pertinent meteorological data was obtained from the National Weather Service (NWS) WBAN station number 081544: Chipley, FL.

Figure 5 provides a time series plot of daily rainfall for the simulation period.

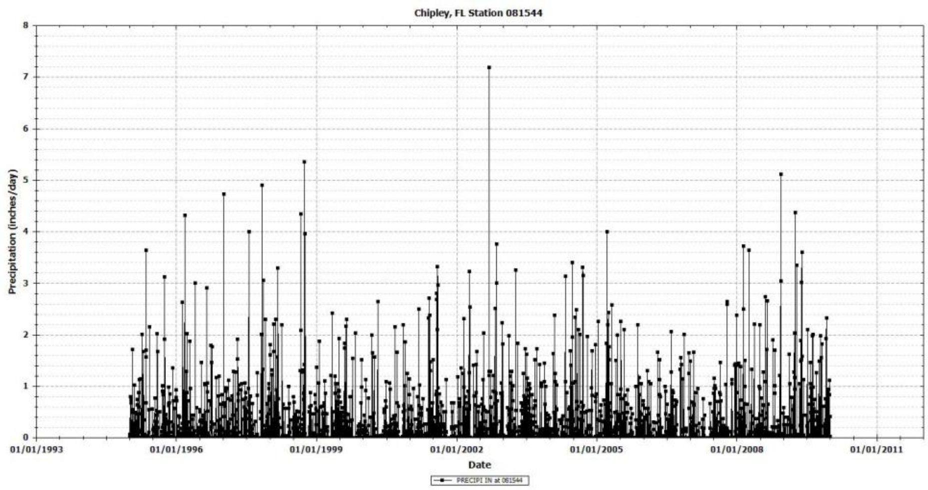


Figure 5 Rainfall for Camp Branch Watershed

Table 2 shows the annual average rainfall for each of the years simulated.

Table 1 Annual Rainfall

Year	Rainfall (inches)
2001	44.2
2002	60.0
2003	73.9
2004	62.7
2005	71.2
2006	65.8
2007	43.7
2008	43.2
2009	67.3
2010	80.7

3.2.2. Flow

Flows were simulated for the Camp Branch watershed using the watershed model and calibrated to extrapolated flows from the USGS gage 02366000 Holmes Creek at Vernon. Flows in the Camp Branch watersheds were determined by the hydrology component of the LSPC watershed model

3.2.3. BOD and Nutrient Loadings

The pollutagraph was generated using event mean concentrations for total nitrogen, total phosphorus and BOD (Table 2Table 1). The initial EMC values were derived for each landuse type from Harpers Report (Harper, 1994) and then calibrated to all data available for the watershed.

Table 2 Camp Branch EMC Values

Landuse Category	BOD5 (mg/l)	TN (mg/l)	TP (mg/l)
Commercial	21.0	3.2	0.62
Cropland	5.6	3.3	0.82
High Density Residential	21.0	3.2	0.62
Industrial	21.0	3.2	0.62
Low Density Residential	5.9	2.0	0.32
Medium Density Residential	9.9	2.5	0.55
Open Water	1.9	1.5	0.09
Rangeland	1.9	1.5	0.09
Recreational	5.6	3.1	0.50
Transportation	7.3	2.1	0.29
Tree Crops	5.6	3.3	0.82
Upland Forest	1.9	1.5	0.09
Wetlands	1.9	2.8	0.64

BOD and nutrient watershed runoff were determined using EMCs for surface water runoff and interflow runoff and baseflow concentrations for groundwater flow. A permitted point source (Bonifay POTW) discharges within the basin and its permitted loading for BOD and nutrients is calculated as a wasteload allocation (WLA). Table 3 provides the annual average total nitrogen, total phosphorus and BOD loads for the period of record 2002 through 2009. It is these loadings that the TMDL load reduction will be calculated from.

Table 3 Camp Branch Nutrient Loads (2002-2009)

	Current Condition	
Constituent	WLA (kg/yr)	LA (kg/yr)
BOD5	15,465	7,991
Total Nitrogen	9,665	3,754
Total Phosphorus	5,799	549

3.3. Camp Branch Water Quality Model

The Camp Branch WASP water quality model integrates the predicted flows and loads from the LSPC model to simulate water quality responses in: nitrogen, phosphorus, chlorophyll a and dissolved oxygen. An 11 segment WASP water quality model was setup to include the 6 Camp Branch sub basins.

3.3.1. WASP Model

The WASP water quality model uses the kinematic wave equation to simulate flow and velocity and the basic eutrophication module to predict dissolved oxygen and Chlorophyll a responses to the BOD, total nitrogen and total phosphorus loadings. Widths were taken from satellite imagery and depths were estimated or taken from the measured water quality data. Table 4 provides the basic kinetic rates used in the model.

Table 4 WASP Kinetic Rates

WASP Kinetic Parameters	Value
Global Reaeration Rate Constant @ 20 °C (per day)	0.01
Sediment Oxygen Demand (g/m2/day)	2.0 to 2.5 for stream segments
Phytoplankton Maximum Growth Rate Constant @20 °C (per day)	4
Phytoplankton Carbon to Chlorophyll Ratio	80
BOD (1-NPS) Decay Rate Constant @20 °C (per day)	0.35
BOD (2-POTW) Decay Rate Constant @20 °C (per day)	0.2
Ammonia, nitrate, phosphorus rates @20 °C (per day)	0.4, 0.2, and 0.3

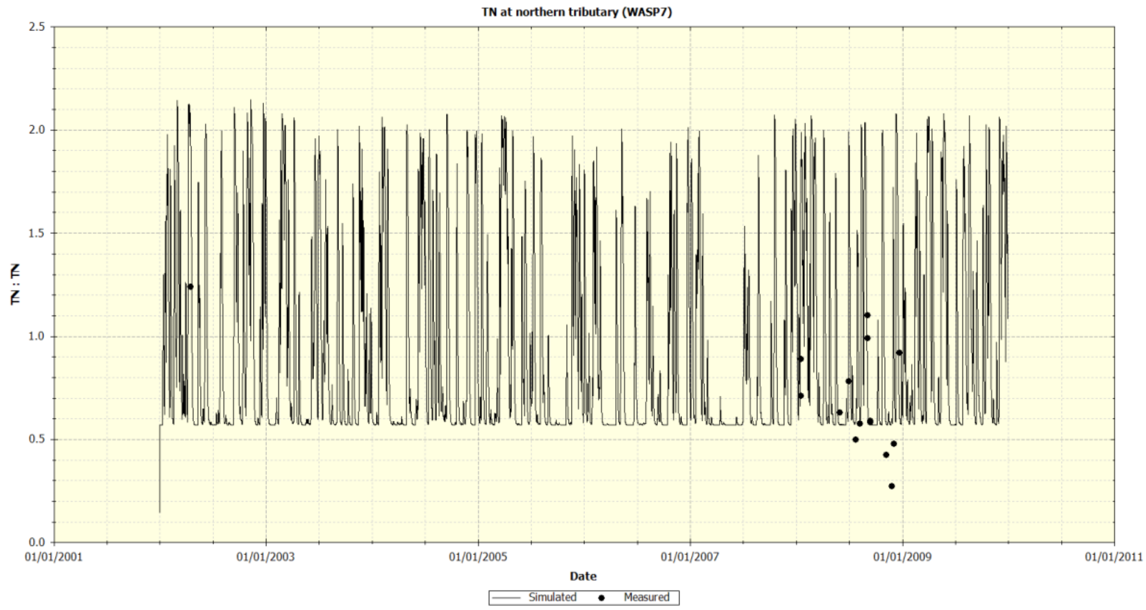
The WASP model was calibrated to all available data available from IWR 44. The downstream most stations were used.

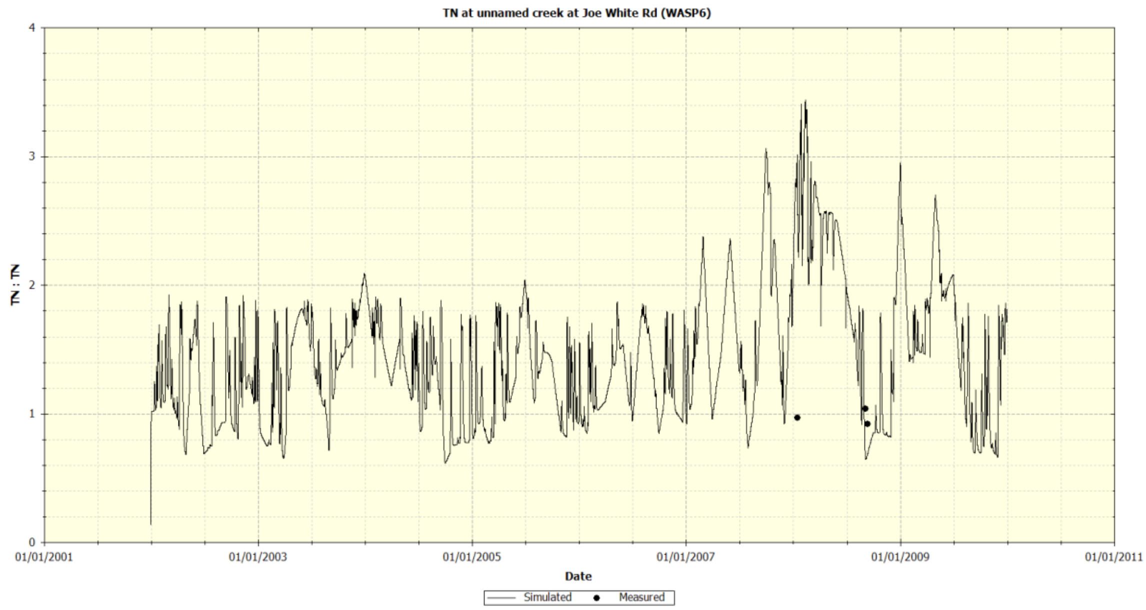
Table 5 provides a comparison of predicted annual average concentrations versus the annual average concentrations of the measured data. It should be noted that only a single year of data was available from Florida's Impaired Waters Rule database version 44.

Table 5 Existing Condition Annual Average Concentrations Observed and Predicted

Constituent	Existing	Observed
BOD5 (mg/L)	1.94	1.79
Chlorophyll a (ug/L)	4.35	5.81
DO (mg/L)	5.49	5.67
Total Nitrogen (mg/L)	1.16	0.76
Total Phosphorus (mg/L)	0.36	0.31

Figure 6 through 10 depict the calibration which compares the observed versus the predicted concentrations.





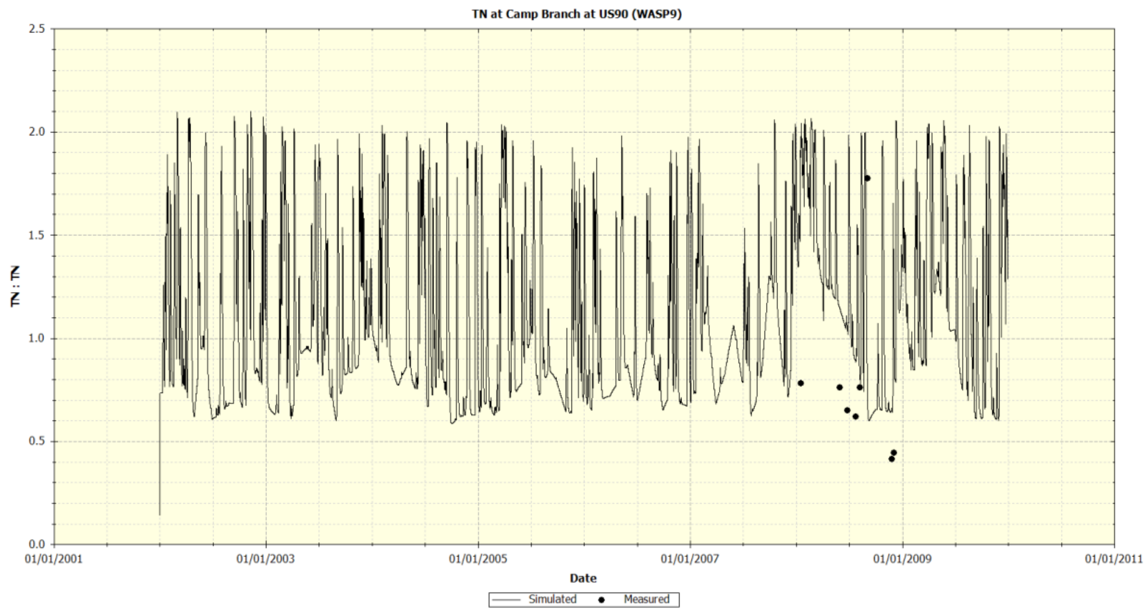
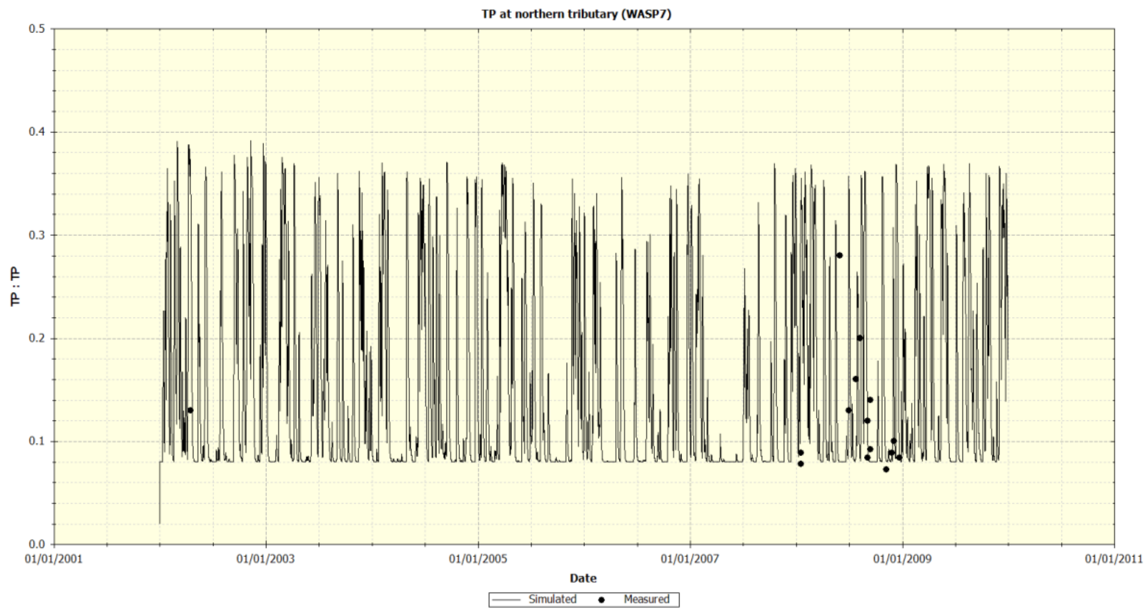
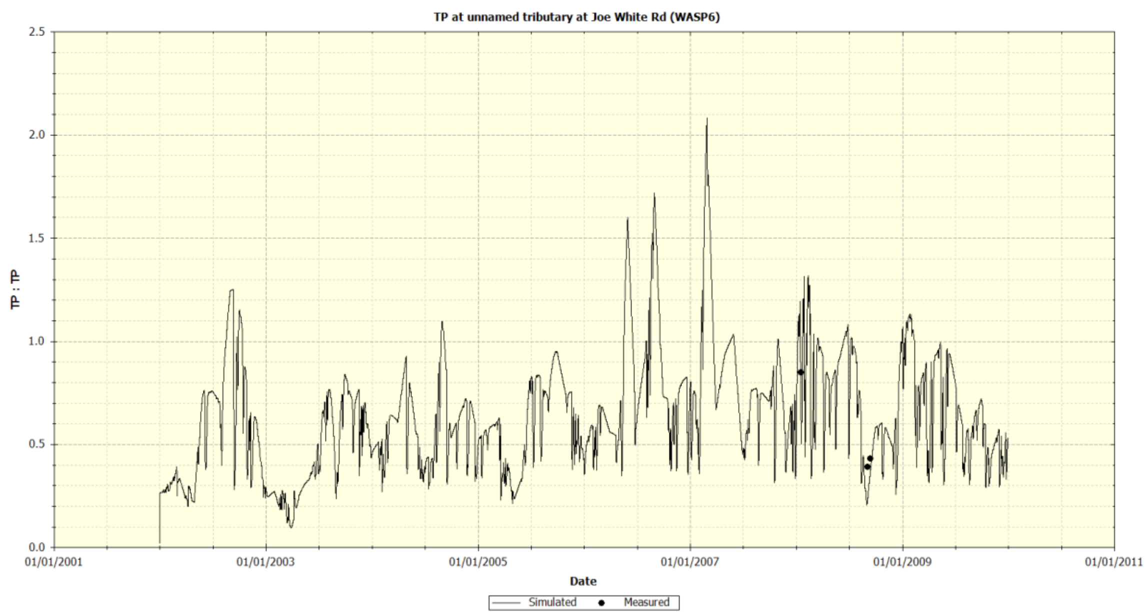


Figure 6 WASP Calibrations for Total Nitrogen in Camp Branch


TP at northern tributary (WASP7)
TP : TP
0.5
0.4
0.3
0.2
0.1
0.0
01/01/2001
01/01/2003
01/01/2005
01/01/2007
01/01/2009
01/01/2011
Date
Simulated
Measured


TP at unnamed tributary at Joe White Rd (WASP6)
TP : TP
2.5
2.0
1.5
1.0
0.5
0.0
01/01/2001
01/01/2003
01/01/2005
01/01/2007
01/01/2009
01/01/2011
Date
Simulated
Measured

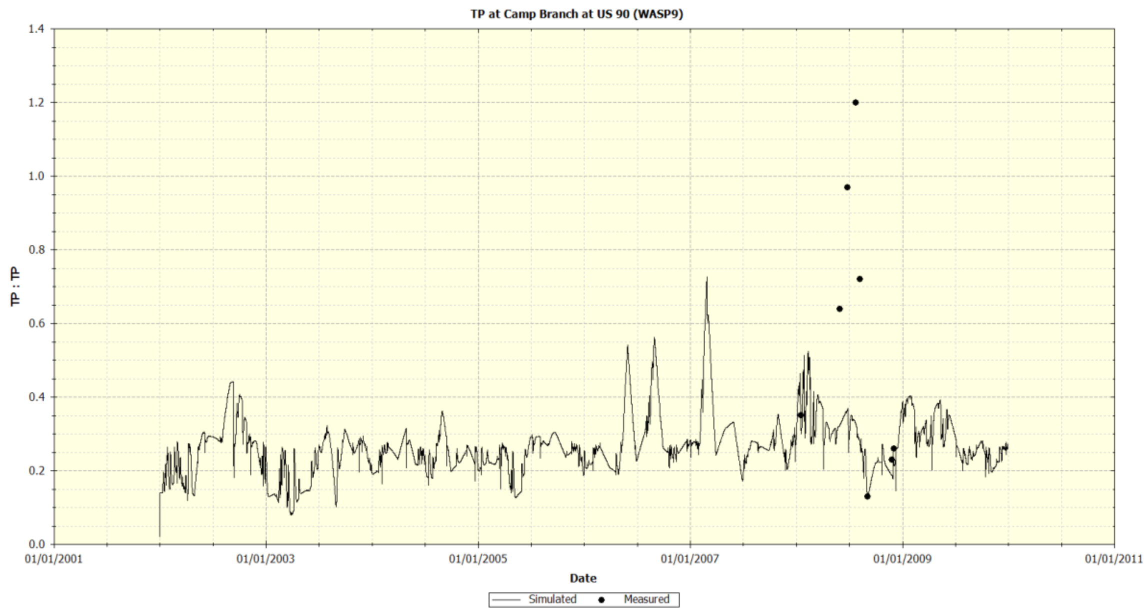
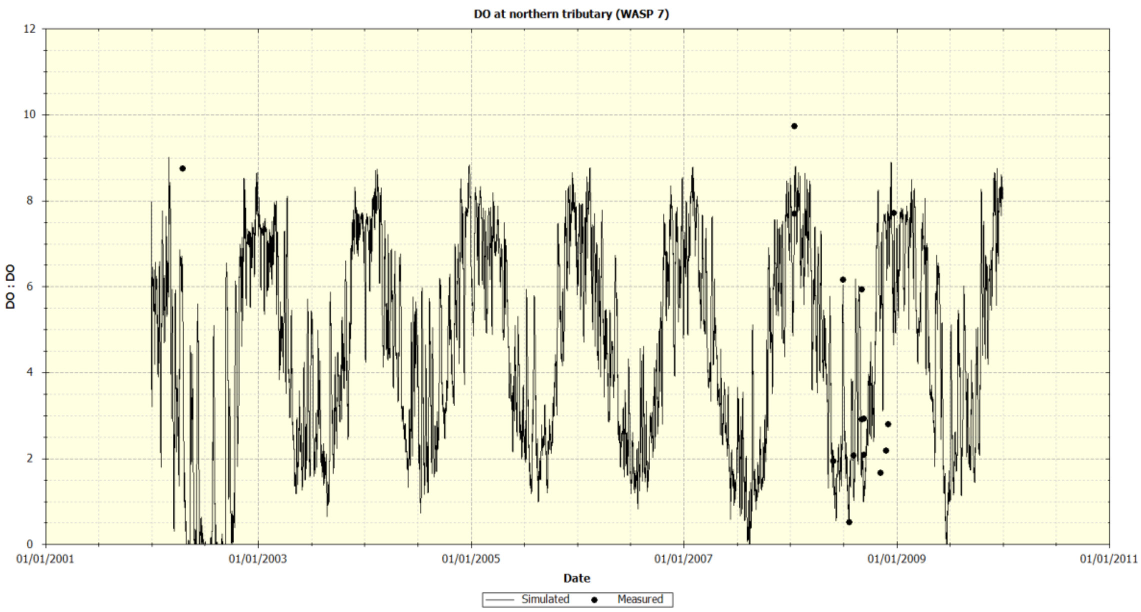
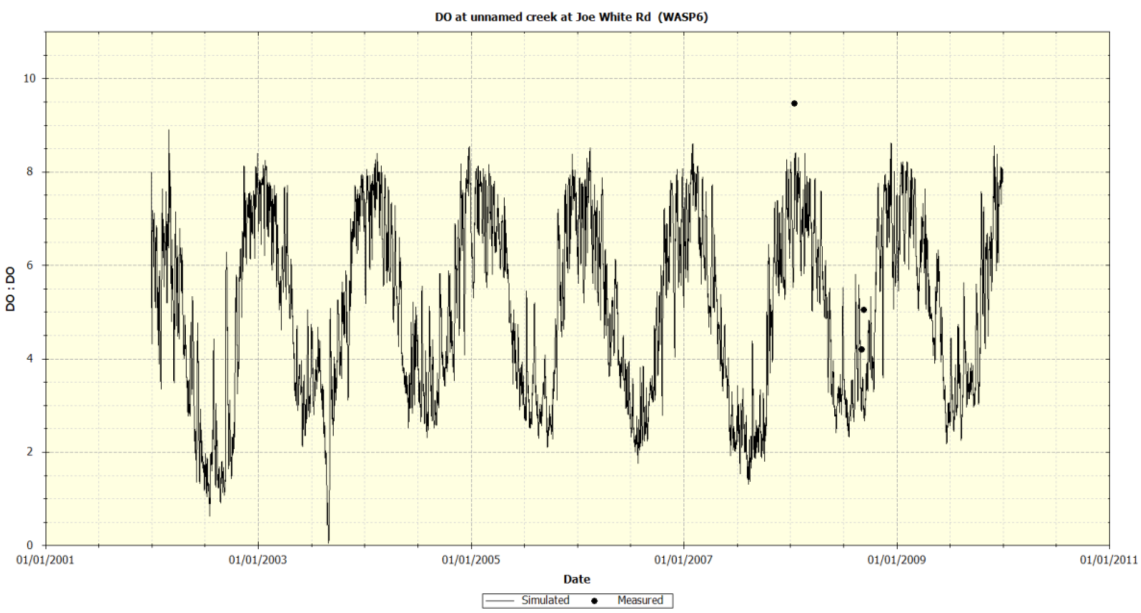


Figure 7 WASP Calibrations for Total Phosphorus in Camp Branch


DO at northern tributary (WASP 7)
DO : DO
Date
01/01/2001
01/01/2003
01/01/2005
01/01/2007
01/01/2009
01/01/2011
Simulated
Measured


DO at unnamed creek at Joe White Rd (WASP6)
DO : DO
Date
01/01/2001
01/01/2003
01/01/2005
01/01/2007
01/01/2009
01/01/2011
Simulated
Measured

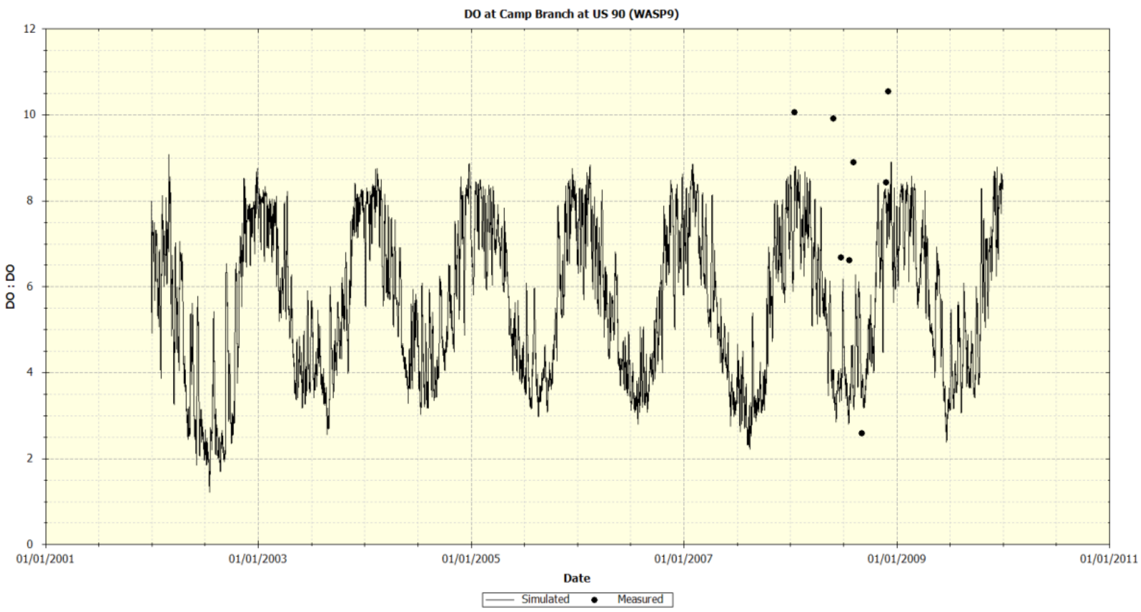
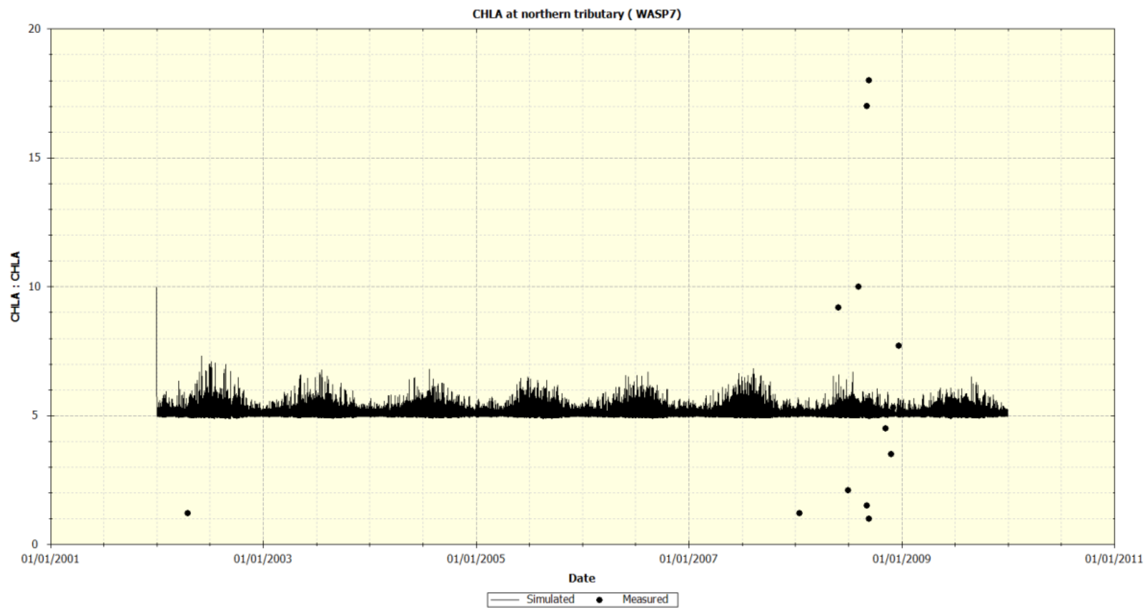
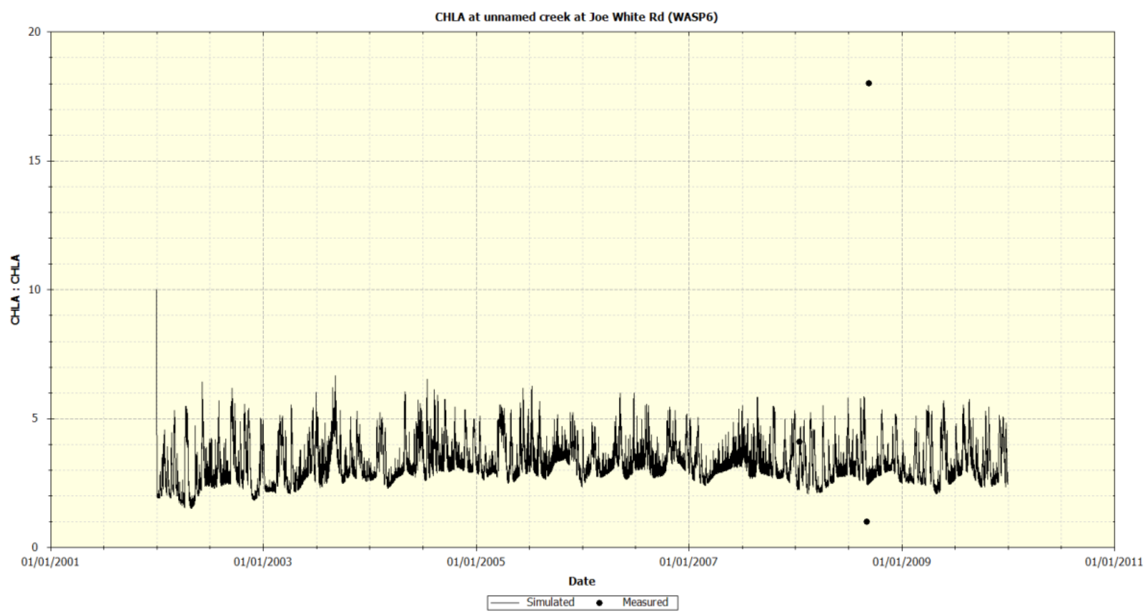


Figure 8 WASP Calibrations for Dissolved Oxygen in Camp Branch


CHLA at northern tributary (WASP7)
CHLA : CHLA
0
5
10
15
20
01/01/2001
01/01/2003
01/01/2005
01/01/2007
01/01/2009
01/01/2011
Date
Simulated
Measured


CHLA at unnamed creek at Joe White Rd (WASP6)
CHLA : CHLA
0
5
10
15
20
01/01/2001
01/01/2003
01/01/2005
01/01/2007
01/01/2009
01/01/2011
Date
Simulated
Measured

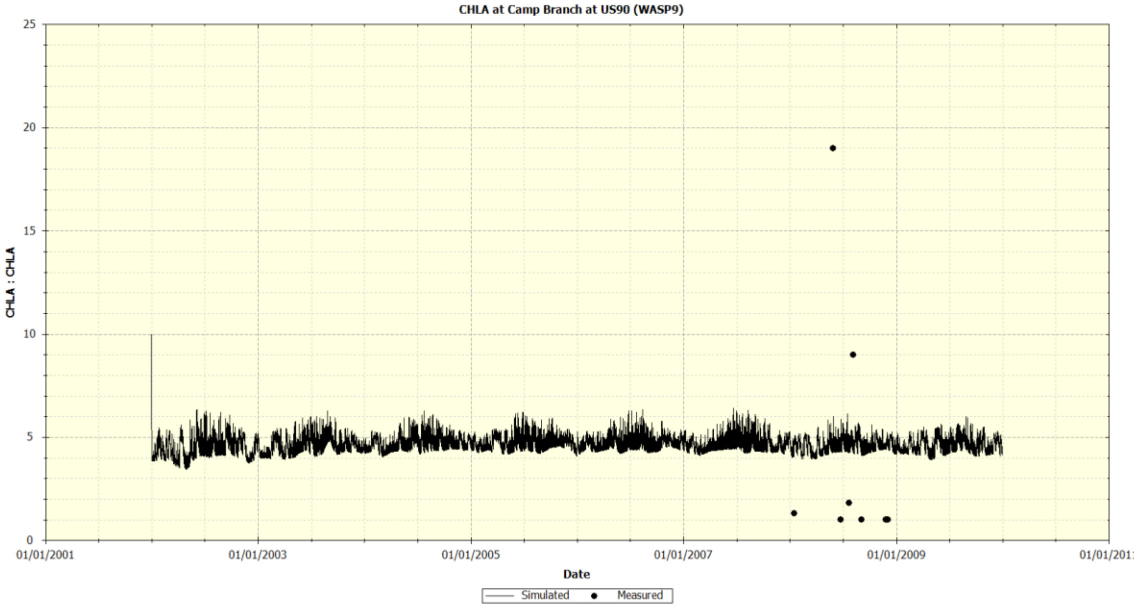
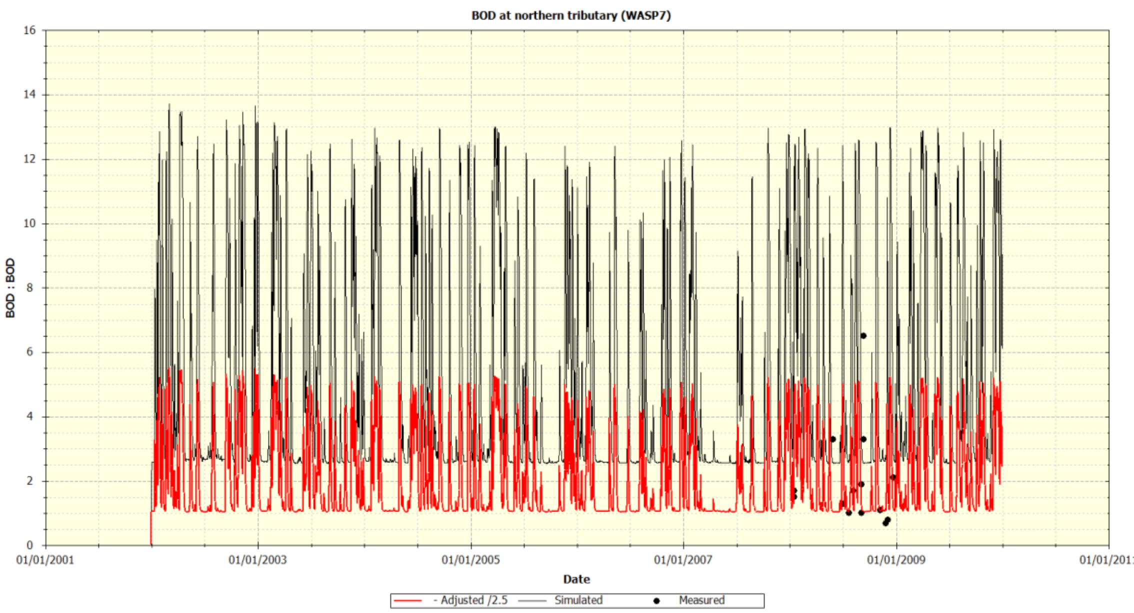
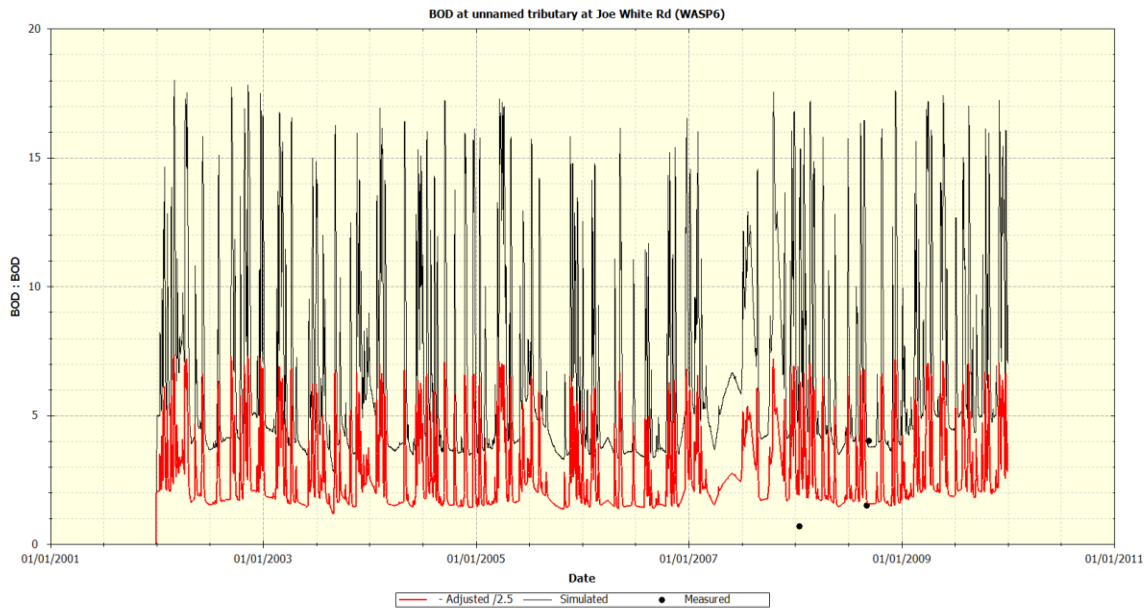


Figure 9 WASP Calibration for Chlorophyll a in Camp Branch





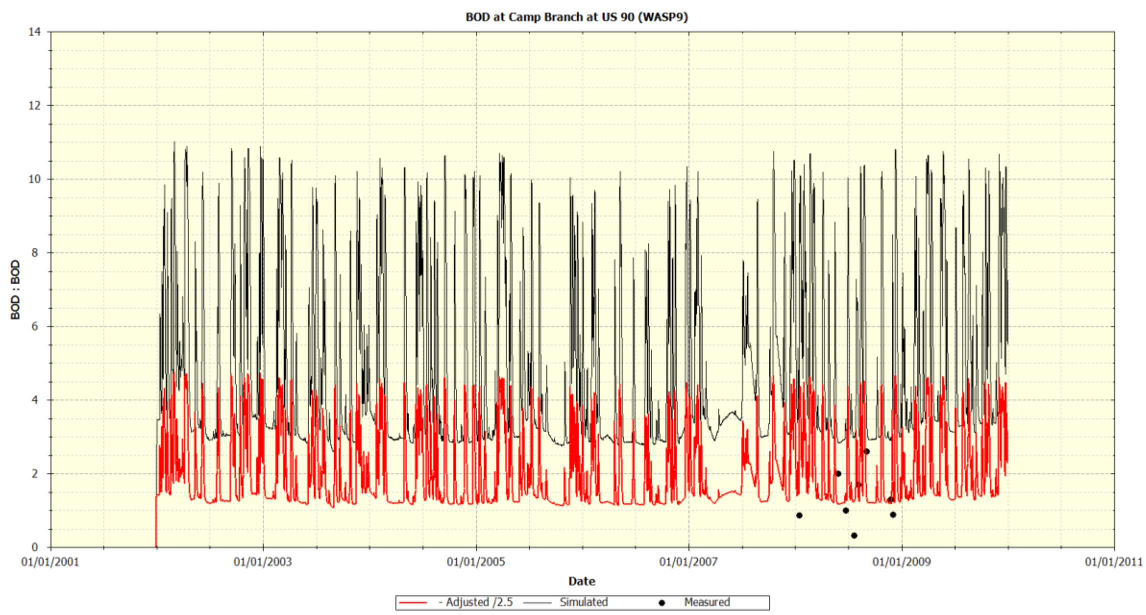


Figure 10 WASP Calibrations for BOD5 (simulated red line vs measured black circle) in Camp Branch

4. Modeling Scenarios

Using the calibrated watershed and water quality models, up to two potential modeling scenarios will be developed. The first scenario will be to predict water quality conditions under a natural condition (remove point sources and returning landuses back to upland forests and wetlands). A second scenario will be developed if water quality standards can be met under natural conditions (balanced flora and fauna, dissolved oxygen greater than 5 mg/L); loads would be reduced from the current conditions until standards are met (balanced flora and fauna, dissolved oxygen greater than 5 mg/L)

4.1. Camp Branch Watershed Natural Condition Analysis

Camp Branch sub basins and upstream landuses were changed from impacted lands to upland forest and wetlands landuses. LSPC was then used to simulate the natural condition nutrient loads (Table 8) which were inputted in to WASP model. In addition, the point source discharge flows and loads were removed from the model. Other than the nutrient load reductions the SOD rate was reduced to reflect the reduced loadings and the urban channel (WASP segment 6) was narrowed to revert the existing canalization. Table 6 provides the annual average model predictions for total nitrogen, total phosphorus, and dissolved oxygen.

Table 6 Annual Average Loadings for Natural Condition

	Natural Condition	
Constituent	WLA (kg/yr)	LA (kg/yr)
Total Nitrogen	0	2,185
Total Phosphorus	0	177
BOD5	0	5,821

Table 7 presents the predicted annual average concentrations under natural conditions.

Table 7 Natural Condition Annual Average Model Predictions

Natural Condition

Constituent	Natural
BOD5 (mg/L)	1.77
Chlorophyll a (ug/L)	5.27
DO (mg/L)	6.57
Total Nitrogen (mg/L)	0.92
Total Phosphorus (mg/L)	0.12

Without the impacts of anthropogenic sources the dissolved oxygen concentration in the Camp Branch still would not achieve the dissolved oxygen standard of 5 mg/l as demonstrated by Figure 11.

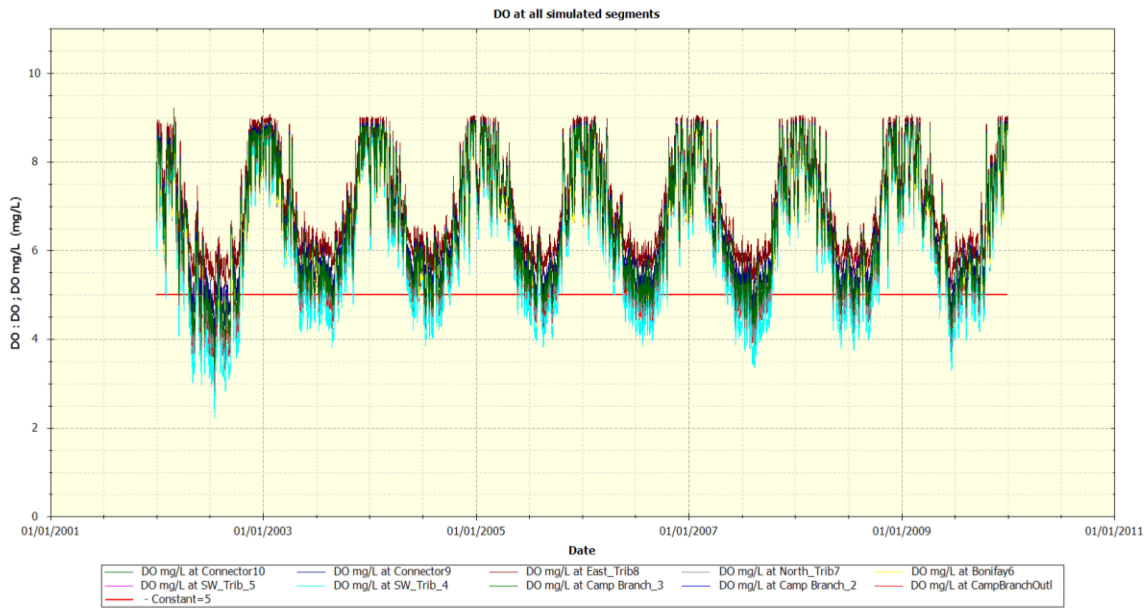


Figure 11 Simulated natural conditions dissolved oxygen concentrations (mg/l) for all segments

5. TMDL Load Reductions

Because water quality standards cannot be met under natural conditions no other scenarios were conducted. The TMDL will be set to the natural conditions.

6. TMDL Determination

The TMDL load reduction was determined by reducing the current conditions to the natural conditions. The annual average loadings are given in Table 8 along with the prescribed load reductions. The wasteload was allocated by applying the existing permitted flow rate to annual average natural conditions concentrations for each constituent. As such, a discharger would not increase in-stream nutrient concentrations above natural annual average background concentrations.

Table 8 TMDL Determination

	Current Condition		TMDL Condition		MS4	LA
Constituent	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	% Reduction	% Reduction
BOD5	15,465	7,991	3,427	5,821	NA	27%
Total Nitrogen	9,665	3,754	1,778	2,185	NA	42%
Total Phosphorus	5,799	549	240	177	NA	68%